Investigation of feature size dependent etching for InP-based photonic crystal devices

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The quality (shape, hole depth) of etching of photonic crystals (PhCs) is very critical as it directly influences their optical properties in terms of losses. Recent results in the InP/InGaAsP/InP material system show that chemically assisted ion beam etching (CAIBE) Ar/Cl_2 is very promising [1,2]. However, important issues such as the feature size dependant etching (FSDE) still require to be well characterized and understood. This knowledge is crucial for the design of high quality PhC-based components such as tapers, bends or cavities which may use different hole diameters in selected regions.

In this work, we systematically investigate the influence of various parameters such as hole diameter (115 to 600 nm), etch duration (10 to 60 min) and ion beam energy (400 to 600 eV) on PhC etching in InP with Ar/Cl_2 CAIBE. For a 60 min etching at an Ar-ion energy of 400 eV, we report an etch depth of 5 μm for hole diameters d larger than 300 nm; the etch depth is in excess of 3 μm for d greater than 200 nm. The mechanism of the observed FSDE is then discussed. The effect of the process parameters is qualitatively understood using a model combining the effect of ion sputtering and surface chemical reactions adapted to explain the experimental FSDE characteristics in the etching of photonic crystals.

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